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Nokia Mobile Phones

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1/38, H04M 1/02 1/03 1/60 1/62 1/72, H04N 5/64,  
H04R 1/02 1/32 1/34

## (54) Loudspeaker housing arrangements

(57) A loudspeaker 401 mounted within a housing 402 is coupled to an offset orifice 403 in the housing by means of an acoustic path 409 defined by loudspeaker support members 403 and 405.

A second arrangement is shown in fig 5.

These arrangements dispense with the need for a protective grille in front of the loudspeaker, and so reduce manufacturing complexity and costs.

These loudspeaker mounting arrangements are particularly useful for mobile telephones, radios, portable laptop computers and other electronic devices.

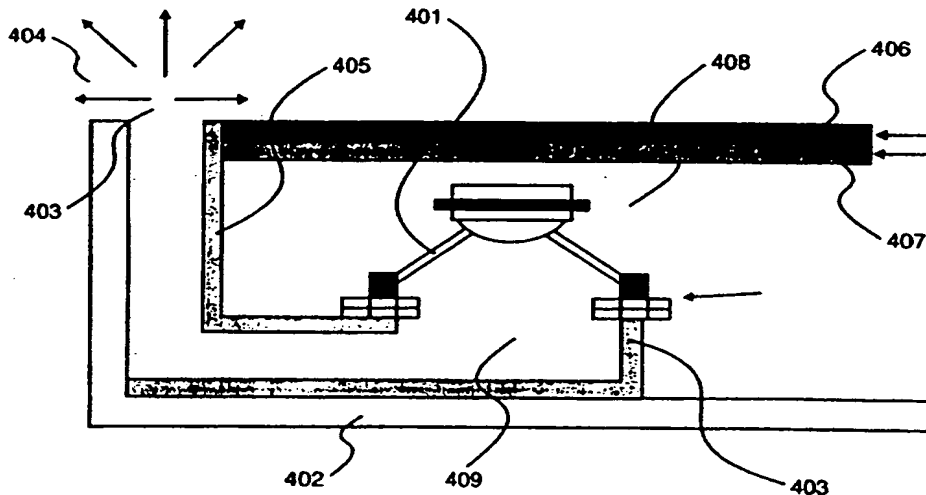


Figure 4

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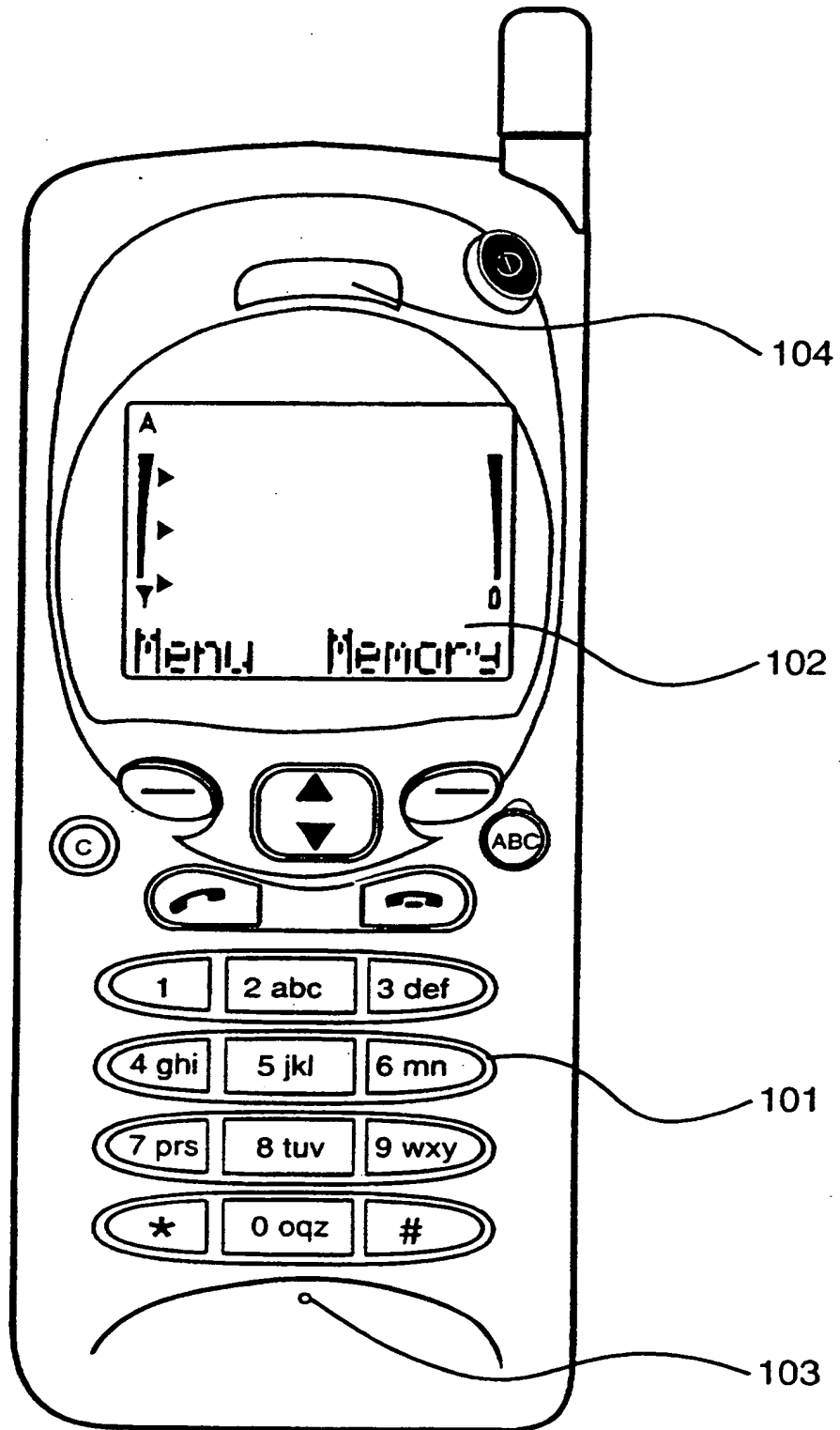


Figure 1

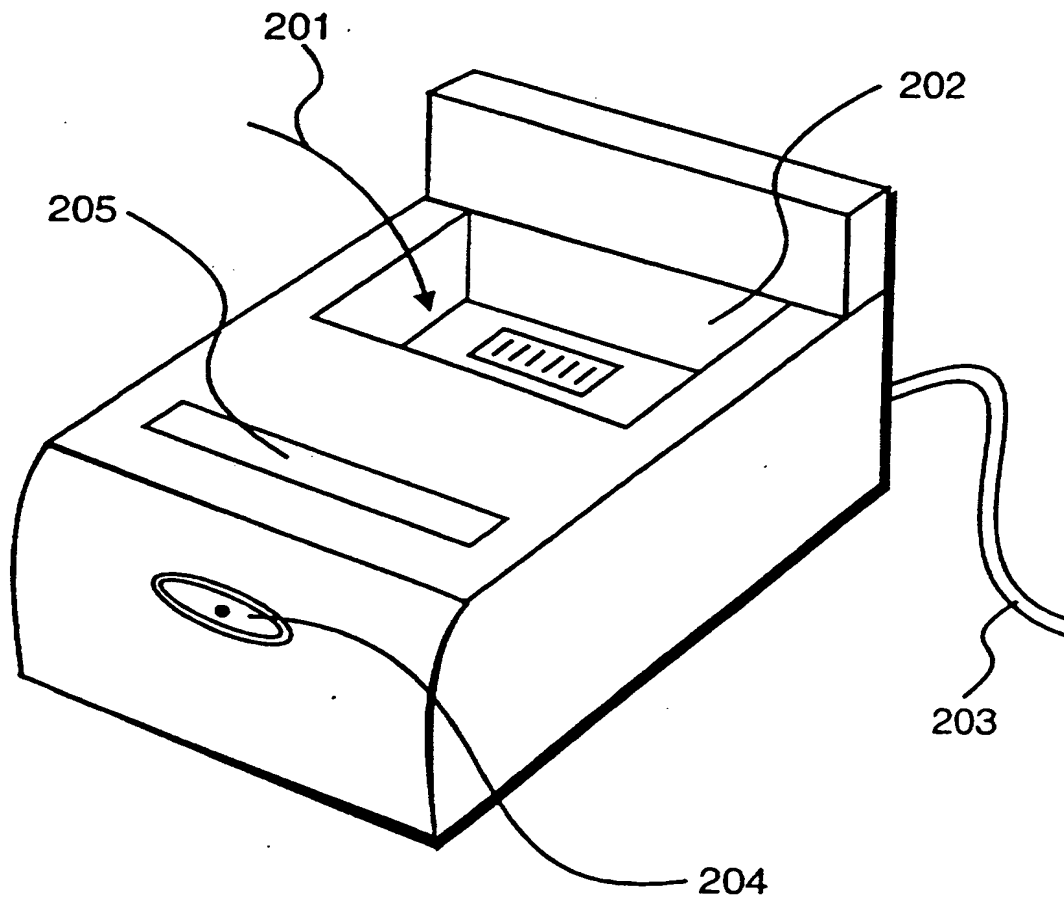


Figure 2

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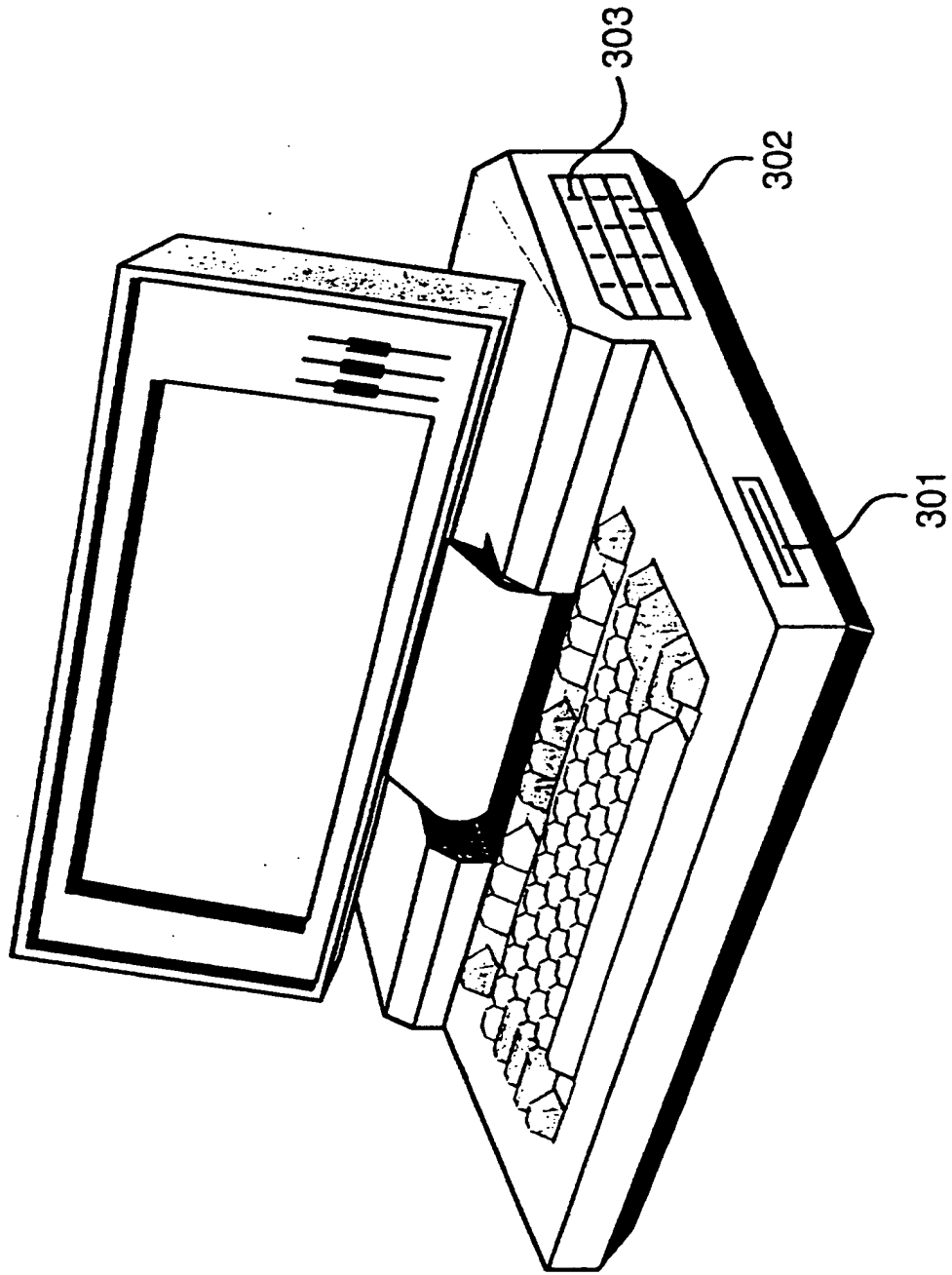


Figure 3

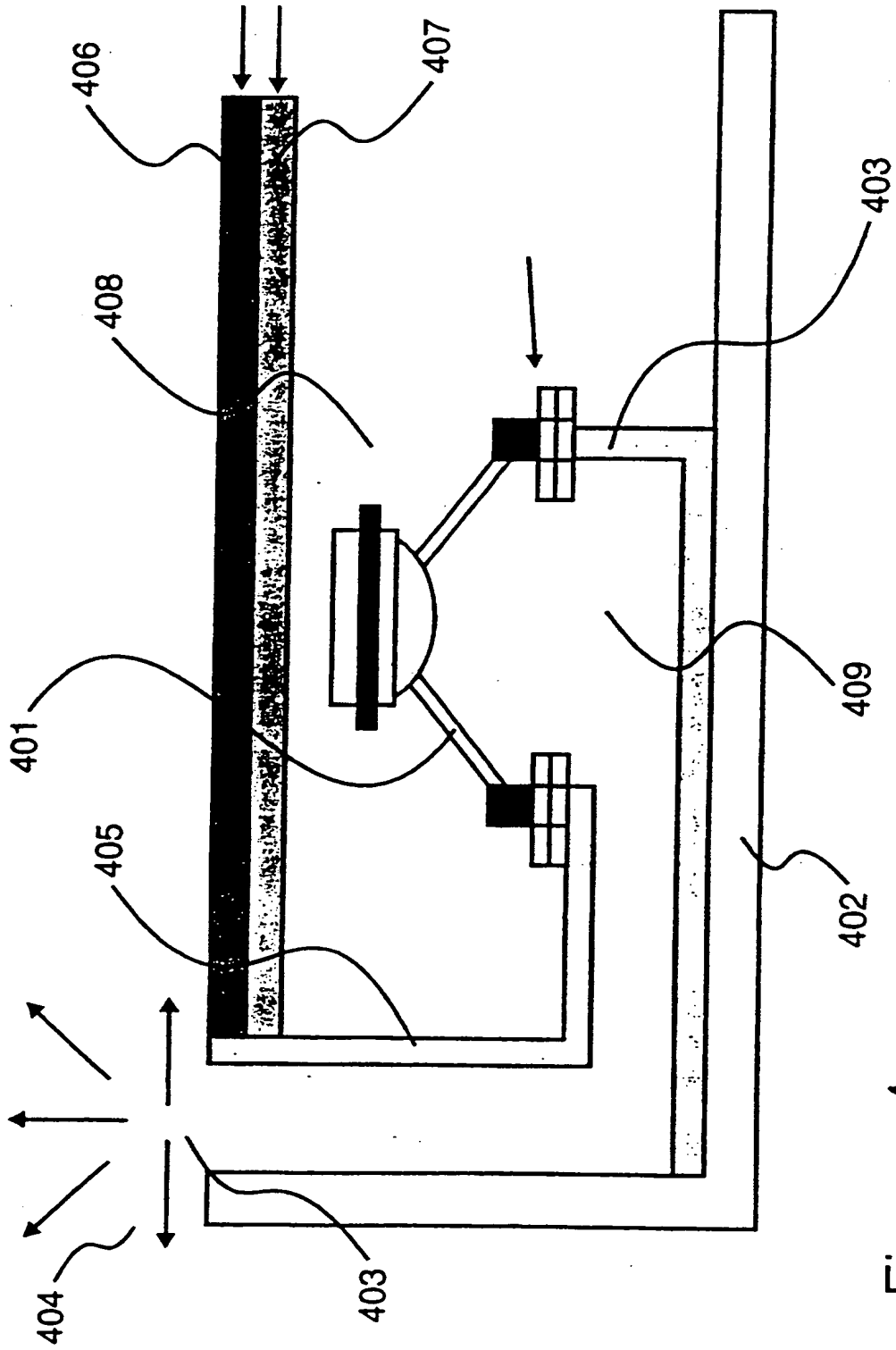


Figure 4

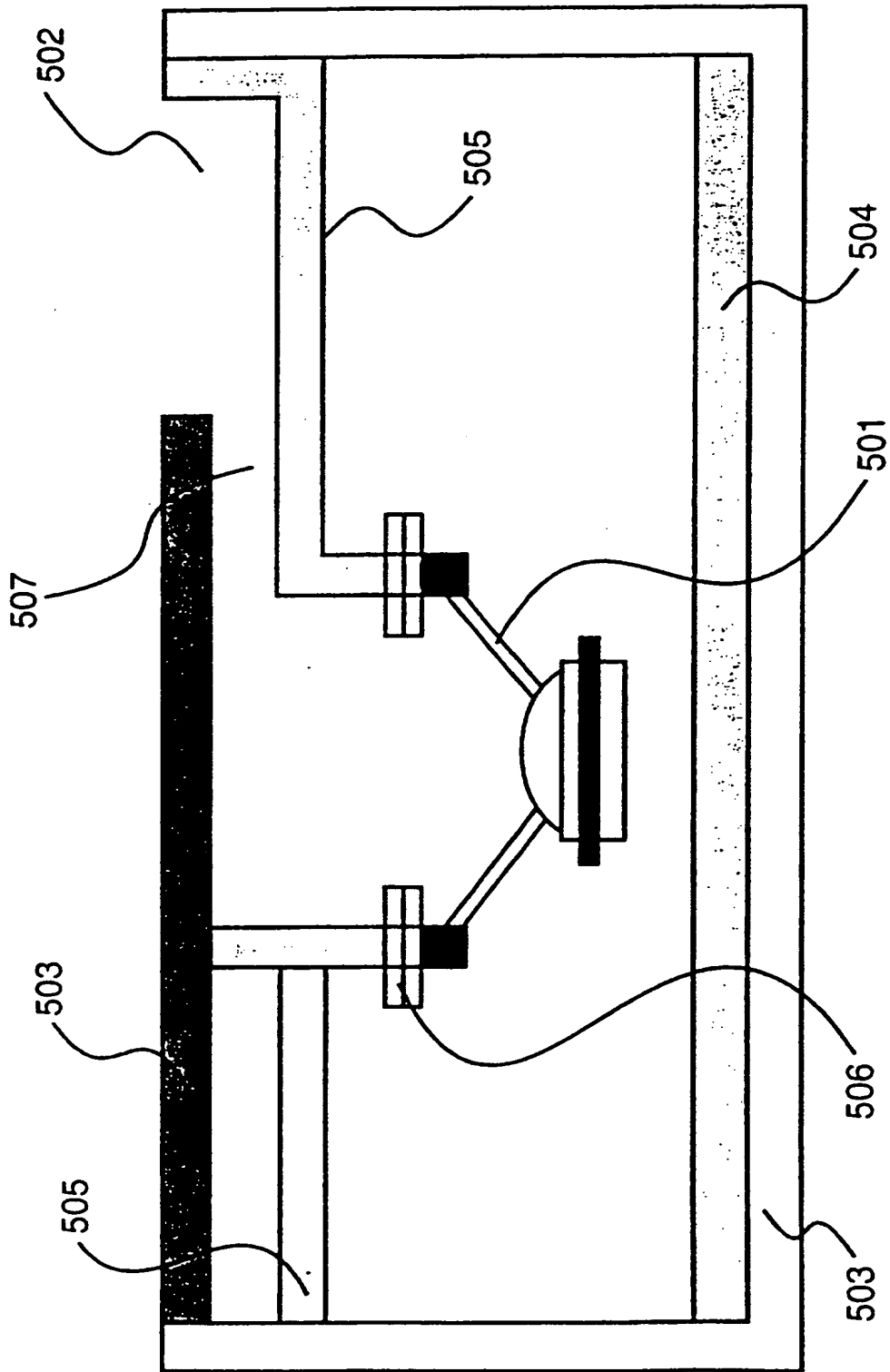


Figure 5

**Title: AUDIO OUTPUT**

The present invention relates to an Audio Output apparatus having an audio signal generating means arranged to generate an audio signal in response to an electrical signal.

**INTRODUCTION**

Many devices are known that require audio output apparatus, in which an audio signal generator is arranged to generate an audio signal in response to an electrical signal. Devices of this type may be used to generate an audio alarm, requiring a simple electrical activation signal or, alternatively, the signal generator may take the form of an electro-acoustic transducer, in which an electrical analog signal is supplied to said transducer, conveying a voltage analog of the resulting output audio signal. Devices of the latter type are often referred to as loudspeakers and are found in many one-way audio transmission systems and two-way audio communication systems, such as telephones, radios and radio telephones, including cellular mobile phones, personal digital assistants, personal computers and portable computers such as lap-top computers.

Conventionally, loudspeakers are arranged such as to allow an audio signal to radiate from a device through perforations, cavities or orifices defined within the housing directly in front of the loudspeaker. In communication devices the overall design is often constrained in terms of component weight and cost, therefore it may not be possible to design a housing from materials that would provide optimum acoustic performance. Often housings are made of relatively lightweight

materials which may result in vibrations and audio distortion when the apparatus is in use.

It is known to protect loudspeakers by merely providing an array of relatively small holes in a housing at a position adjacent to the loudspeaker diaphragm. Such an arrangement is particularly unsuitable if the loudspeaker is not necessarily arranged to be positioned directly adjacent to, and possibly in contact with, a user's ear. Small holes present high acoustic resistances, which in turn impede the transmission of sound to the surrounding environment. This in turn may lead to a build up in pressure between a housing and a printed circuit board, for example resulting in an impairment of reliability. Furthermore, for a given energy input, an increased proportion of this energy will be dissipated rather than being transmitted as sound. The sound may be distorted by non-linear effects and component vibration may also introduce additional unwanted noise.

The effects identify a particular problem that is experienced if a higher output sound level is required. Increasing input energy will often result in a far higher level of energy distortion and vibration, without significantly increasing output levels.

Loudspeakers are often attached to printed circuit boards and in addition to providing less than optimum audio characteristics, vibrations set up by loudspeakers may also reduce the reliability of PCB components and affect solder joints. In addition, many constraints may affect the actual positioning of a PCB within a housing, in addition to providing a loudspeaker at an optimum position for use.

In mobile phones, known implementations involve locating a loudspeaker such that it is directly located behind an orifice for



conveying audio signals to the ambient sound conveying medium, usually air adjacent to a user's ear. The positioning of a loudspeaker in this way will place additional constraints upon the location of components within a printed circuit board and will also require  
5 protecting elements to be fabricated in front of the loudspeaker so as to protect said loudspeaker from mechanical intrusion.

### **SUMMARY OF THE INVENTION**

According to a first aspect of the present invention, there is provided an audio output apparatus, comprising: audio signal generating  
10 means arranged to generate an audio signal in response to an electrical signal; a housing defining an orifice, wherein said orifice is arranged to convey audio signals generated by said generating means to an ambient sound conveying medium; support means arranged to support said  
generating means within said housing at a position displaced from said  
15 orifice; and sound directing means defining a transmission path within said housing and arranged to direct sound from said generating means to said output orifice.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 shows a mobile telephone housing, arranged to constrain  
20 an audio output apparatus embodying the present invention;

Figure 2 shows a mobile telephone hands-free unit, having a housing arranged to hold audio output apparatus embodying the present invention;

Figure 3 shows a lap-top computer including audio output  
25 apparatus embodying the present invention;

Figure 4 illustrates a first embodiment of an audio output apparatus, suitable for application with the devices shown in Figures 1 to 3; and

Figure 5 illustrates an alternative embodiment to that shown in Figure 4.

## **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

Preferred embodiments of the invention will now be described by way of example only with reference to the accompanying drawings identified above.

A mobile telephone is shown in Figure 1 having a plurality of manually operable keys 101 and a visual display device 102. In response to manual operation of said keys 101, information is displayed on said display device 102, to facilitate the establishment of calls and operator configuration. During a call a user directs speech towards an audio input orifice 103. Similarly, output audio signals are directed towards a user's ear via an output orifice 104. In this embodiment, output audio signals are generated by a loudspeaker, having a diaphragm. However, the diaphragm of said loudspeaker is not located directly behind orifice 104, therefore it is not necessary to provide protective elements which in turn reduce the effective area of said orifice.

A hands-free unit for a mobile telephone is shown in Figure 2. A mobile telephone of the type illustrated in Figure 1 may be received, as illustrated by arrow 201, within a support cup 202. When located within said support cup 202, a rechargeable battery attached to the telephone

may be recharged, with electrical power being received from a mains power supply via a cable 203. In addition, an audio input device (such as device 103) and an audio output device (such as device 104) may be replaced by similar devices 204, 205 respectively, thereby allowing the mobile telephone to operate in a hands-free mode. A device shown in Figure 2 is a desk-top model, primarily arranged to recharge a mobile telephone but, in addition,

similar configurations may be provided within motor vehicles, allowing a driver to accept telephone calls while the vehicle is being brought to a standstill.

The hands-free unit shown in Figure 2 includes a loudspeaker having a diaphragm, but again the loudspeaker is not arranged directly behind an output orifice 205, thereby removing the necessity for protective mechanical elements to be positioned in front of said diaphragm.

A lap-top computer is illustrated in Figure 3, having an in-built power supply to provide a mobile data processing environment. The computer is also provided with an interface slot 301 to facilitate data transfer via a digital mobile telephone, such as a mobile telephone conforming to the GSM recommendations.

The computer shown in Figure 3 also includes a so-called sound card or similar device for converting digital signals into an analog audio signal that may in turn be supplied to a loudspeaker or similar electro-audio transducer. An output orifice 302 is provided to facilitate the direction of sound from within the computer housing to ambient conditions. However, the loudspeaker is not positioned directly behind said orifice and a protective grill 303 provides minimal protection, given

that the loudspeaker diaphragm is not so positioned. This arrangement also improves output sound transmission.

A cross section of the hands-free unit shown in Figure 2 is illustrated in Figure 4. An audio signal generator in the form of a loudspeaker 401 is provided, held within a housing 402. The housing 402 defines an output orifice 403, from which output audio signals emanate, as illustrated by arrows 404. The loudspeaker 401 is supported by a rigid chassis 403 such as to displace the loudspeaker 401 relative to the output orifice 403. The loudspeaker 401 is also supported by a rigid support member 405 such that the chassis 403 and support member 405 define a transmission path between the loudspeaker 401 and the output orifice 403.

The housing includes an outer case portion 406 which is in turn arranged to support a printed circuit board 407. Loudspeaker 401 is not physically mounted to the circuit board 407, thereby reducing vibrational effects so as to reduce sound degradation and reduce physical loading upon the PCB. Air space 408 is made available behind the loudspeaker diaphragm to provide rear loading upon said diaphragm with a front duct 409, defined between elements 402 and 405, providing a front loading area. In use, audio signals generated by the loudspeaker 401 will be directed through duct 409 towards output orifice 403, without being restrained by protective elements thereby reducing overall acoustic resistance. In this way, output volume is increased for a given input power and vibration is reduced, for a given material strength, with less sound coloration.

In the embodiment shown in Figure 4 the loudspeaker 401 is effectively rearwardly facing relative to the output orifice 404. An

alternative configuration is shown in Figure 5 in which a loudspeaker 501 has a diaphragm with a front surface directing sound in a direction substantially similar to that of the output direction of an orifice for 502. However, orifice 502 is displaced relative to the position of said loudspeaker.

A device is contained within a housing 503 and a circuit board 504 is mounted to part of said housing. The loudspeaker 501 is held in position by support members 505 and a gasket 506 is held in position between said loudspeaker 501 and support members 505.

The loudspeaker 501 is not in direct contact with the circuit board 504 and sound generated by the loudspeaker is directed along a transmission path 507 within the housing 503 towards the orifice 502. Thus, there are no mechanical restricting elements between the loudspeaker 501 and the output orifice 502 but by being displaced from said orifice, it is not possible for the loudspeaker to be damaged by objects being directed thru orifice 502.

**CLAIMS**

1. An audio output apparatus, comprising:  
audio signal generating means arranged to generate an audio  
signal in response to an electrical signal;  
5 a housing defining an orifice, wherein said orifice is arranged to  
convey audio signals generated by said generating means to an ambient  
sound conveying medium;  
support means arranged to support said generating means within  
said housing at a position displaced from said orifice; and  
10 sound directing means defining a transmission path within said  
housing and arranged to direct sound from said generating means to said  
output orifice.
2. Apparatus according to Claim 1, wherein said audio signal  
generating means is an electro-audio transducer arranged to receive an  
15 analog electrical signal.
3. Apparatus according to Claim 2, wherein said transducer is  
a loudspeaker having a diaphragm.
4. Apparatus according to Claim 1, wherein said orifice is  
open with no restricting mechanical elements positioned within said  
20 orifice opening and said ambient medium.

5. Apparatus according to Claim 1, wherein said support means are connected to said rigid chassis without being connected to a circuit board.

6. Apparatus according to any of Claims 1 to 5, wherein an active surface of said loudspeaker is positioned in a direction substantially opposite to that of said orifice.

7. A mobile telephone including an audio output apparatus according to any of Claims 1 to 6.

8. A support device for a mobile telephone including an audio output apparatus according to any of Claims 1 to 6.

9. A support apparatus according to Claim 8, including means for facilitating hands-free operation of said mobile telephone.

10. A data processing device including audio output apparatus according to any of Claims 1 to 6.

11. A data processing device according to claim 10, operational as a personal digital assistant, a personal computer, a portable game playing device or a lap-top computer.

12. In an electronic device having a housing and configured to project sound to an ambient sound conveying medium, a method of

transmitting sound from a an audio signal generating device, comprising steps of:

- defining an orifice in said housing;
- supporting said audio signal generating device within said housing
- 5 at a position displaced from said housing; and
- directing sound generated by said generating device via a transmission path within said housing.

13. An audio output apparatus substantially as herein described with reference to Figure 4 or Figure 5.

10 14. A mobile telephone hands-free unit substantially as herein described with reference to Figures 2 and 4.



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**Amendments to the claims have been filed as follows**

1. An audio output apparatus, comprising:  
audio signal generating means arranged to generate an audio  
5 signal in response to an electrical signal;  
a housing defining an orifice, wherein said orifice is arranged to  
convey audio signals generated by said generating means to an ambient  
sound conveying medium;  
a circuit board with devices for processing said electrical signal;  
10 support means arranged to support said generating means within  
said housing at a position displaced from said orifice without being  
connected to said circuit board; and  
sound directing means defining a transmission path within said  
housing and arranged to direct sound from said generating means to said  
15 output orifice.

2. Apparatus according to Claim 1, wherein said audio signal  
generating means is an electro-audio transducer arranged to receive an  
analog electrical signal.

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3. Apparatus according to Claim 2, wherein said transducer is  
a loudspeaker having a diaphragm.

4. Apparatus according to Claim 1, wherein said orifice is  
25 open with no restricting mechanical elements positioned within said  
orifice opening and said ambient medium.

5. Apparatus according to any of Claims 1 to 4, wherein an active surface of said loudspeaker is positioned in a direction substantially opposite to that of said orifice.

5 6. A mobile telephone including an audio output apparatus according to any of Claims 1 to 5.

7. A support device for a mobile telephone including an audio output apparatus according to any of Claims 1 to 5.

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8. A support apparatus according to Claim 7, including means for facilitating hands-free operation of said mobile telephone.

9. A data processing device including audio output apparatus  
15 according to any of Claims 1 to 5.

10. A data processing device according to claim 9, operational as a personal digital assistant, a personal computer, a portable game playing device or a lap-top computer.

20

11. An audio output apparatus substantially as herein described with reference to Figure 4 or Figure 5.



Application No: GB 9603826.0  
Claims searched: 1 to 12

Examiner: Peter Easterfield  
Date of search: 7 May 1996

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.O): G4A (ADT); H3Q (QACX, QAG); H4F (FJH, FJL); H4J (JA, JAAB, JAB, JBA, JEP, JK, JL); H4X (X3)

Int CI (Ed.6): G06F 3/16; G10K 11/22; H04B 1/034, 1/08, 1/38; H04M 1/02, 1/03, 1/60, 1/62, 1/72; H04N 5/64; H04R 1/02, 1/32, 1/34

Other:

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
X	GB 1567548 A (ELMEG) see fig 4	1-4, 12
X	GB 1556794 A (MOTOROLA) see fig 2	1-3, 11 & 12
X	GB 0611558 A (NEWTON) see fig 3	1-5, 12
X	GB 0434134 A (SHIPTON) see fig 6	1-4, 12
X	GB 0274689 A (SPERO) see the fig	1-5, 12
X	EP 0598391 A2 (MATSUSHITA) see fig 1	1-5, 12
X	EP 0519509 A2 (DAEWOO) see figs 1 & 4	1-5, 12
X	EP 0451885 A1 (PHILIPS) see fig 2	1-5, 12
X	EP 0429121 A1 (PHILIPS) see fig 3	1-5, 12
X	EP 0377262 A2 (POLK) see fig 5	1-6, 12
X	US 5440646 A (SETTLES <i>et al</i> ) whole document	1-4, 12
X	US 4452333 A (PEAVEY <i>et al</i> ) see fig 2	1-5, 12

X Document indicating lack of novelty or inventive step  
Y Document indicating lack of inventive step if combined with one or more other documents of same category.

& Member of the same patent family

A Document indicating technological background and/or state of the art.  
P Document published on or after the declared priority date but before the filing date of this invention.  
E Patent document published on or after, but with priority date earlier than, the filing date of this application.



The  
Patent  
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Application No: GB 9603826.0  
Claims searched: 1 to 12

Examiner: Peter Easterfield  
Date of search: 7 May 1996

Category	Identity of document and relevant passage	Relevant to claims

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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